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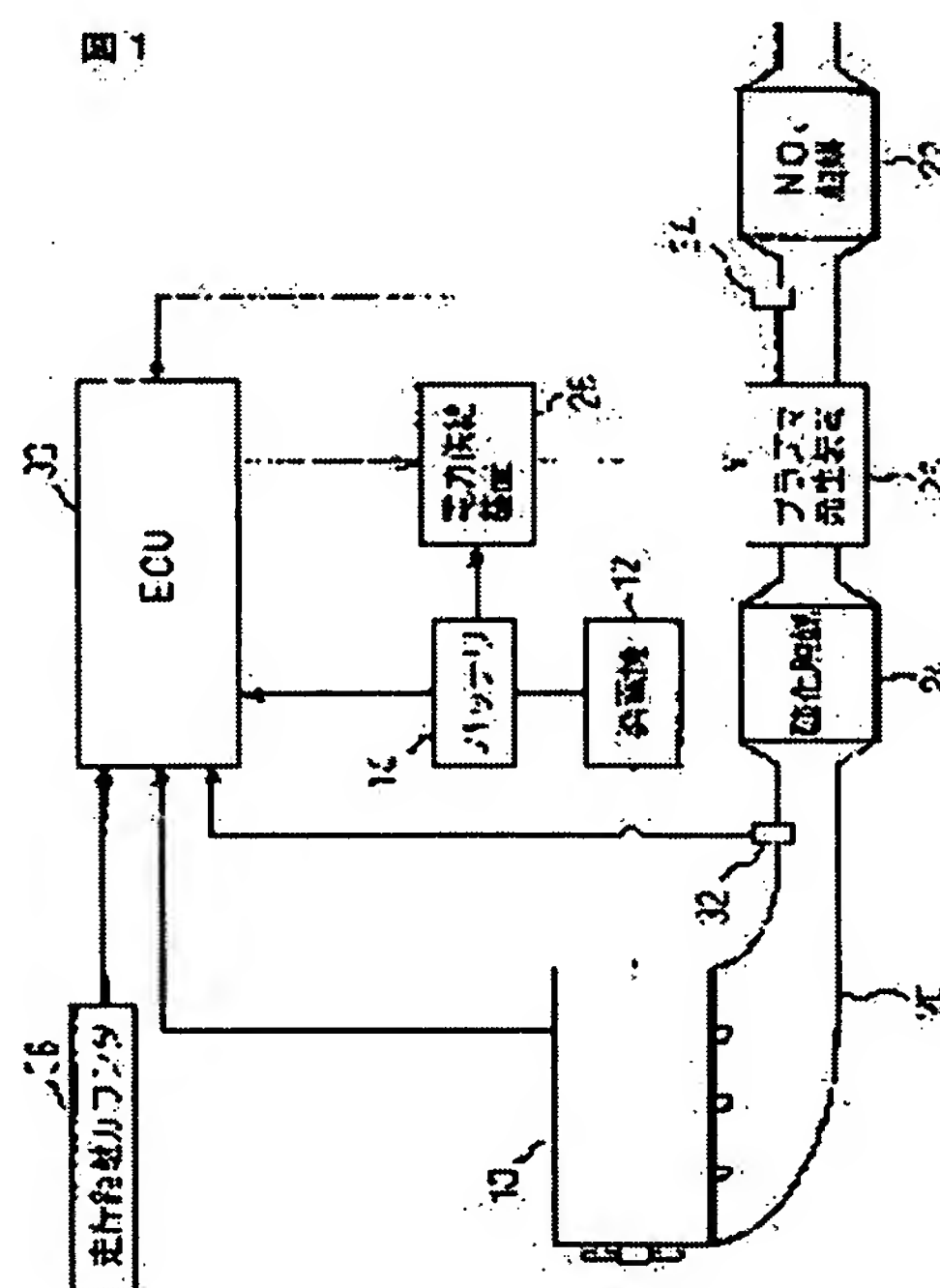
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## (54) EXHAUST GAS PURIFYING DEVICE OF INTERNAL COMBUSTION ENGINE

(57)Abstract:

PROBLEM TO BE SOLVED: To improve a purifying efficiency by suppressing the energy consumption with effectively operating a plasma generator and promoting the emission and the reduction of hazardous substances such as NOX, SOX occluded in the catalyst in an exhaust gas purifying device arranging the occlusion reducing NOX type catalyst and the plasma generator at an exhaust passage of the internal combustion engine.

SOLUTION: When the process for emitting the hazardous substances occluded in the occlusion reducing type NOX catalyst 22 is performed, the plasma generator 26 is operated. When the temperature of the occlusion reducing type NOX catalyst 22 is not greater than the determined first temperature or even when it is not less than the determined second temperature higher than the first temperature, the plasma generator 26 is operated. In the other case, the plasma generator 26 is stopped to operate.



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CLAIMS

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[Claim(s)]

[Claim 1] while an occlusion reduction type NOX catalyst is arranged in a flueway -- this occlusion reduction type NOX catalyst -- the flueway of the upstream -- or an internal combustion engine's exhaust emission control device characterized by establishing the control means which operates said plasma generator when processing to which the harmful matter by which occlusion was carried out to said occlusion reduction type NOX catalyst is made to emit in this occlusion reduction type NOX catalyst and the exhaust emission control device of the internal combustion engine with which the plasma generator has been arranged in one is performed.

[Claim 2] Said control means is the exhaust emission control device of the internal combustion engine according to claim 1 which operates said plasma generator further when the temperature of said occlusion reduction type NOX catalyst is below the first predetermined temperature, or also when it is beyond the second predetermined temperature higher than this first temperature.

[Claim 3] The exhaust emission control device of an internal combustion engine according to claim 1 or 2 with which an oxidation catalyst is arranged at the preceding paragraph of said occlusion reduction type NOX catalyst, and said plasma generator is arranged between said oxidation catalyst and said occlusion reduction type NOX catalyst.

[Claim 4] The exhaust emission control device of an internal combustion engine given in any 1 term from claim 1 to claim 3 with which said occlusion reduction type NOX catalyst is supported in the particle matter by the filter in which uptake is possible.

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DETAILED DESCRIPTION

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[Detailed Description of the Invention]

[0001]

[Field of the Invention] This invention relates to an internal combustion engine's exhaust emission control device.

[0002]

[Description of the Prior Art] While a lean combustion (lean burn) engine is developed in a gasoline engine from a viewpoint of the economical efficiency of a fuel, the applicability of a Diesel engine is being expanded. In a Diesel engine or a lean combustion gasoline engine, since a fuel is made to burn under a big excess air factor, while there are few discharges of HC (hydrocarbon) and CO (carbon monoxide) which are an incomplete combustion component, the discharge of NOX (nitrogen oxides) by which the nitrogen in air and the oxygen of a cinder react and are generated increases.

[0003] Thus, in order to reduce the burst size to the inside of the atmospheric air of harmful NOX generated comparatively so much, arranging an occlusion reduction type NOX catalyst in an engine exhaust air system is known. An occlusion reduction type NOX catalyst carries out reduction purification of the emitted NOX by reduction components, such as HC in exhaust gas, and CO, while it absorbs NOX with the gestalt of a nitrate and it emits NOX absorbed when the oxygen density in exhaust gas became low, when the oxygen density in exhaust gas is high. thus, in the internal combustion engine having an occlusion reduction type NOX catalyst, an oxygen density absorbs NOX good out of the exhaust gas of high lean combustion, and periodical -- rich -- gaseous mixture - - while reducing the oxygen density in exhaust gas, reduction components, such as HC and CO, are made to exist in exhaust gas by combustion operation (rich spike operation), and it can return and purify good, without making absorbed NOX emit into atmospheric air.

[0004] By the way, sulfur is contained in the fuel for an internal combustion engine, and SOX is also generated on the occasion of combustion. SOX oxidizes like NOX to an occlusion reduction type NOX catalyst, and is absorbed with the gestalt of a sulfate. since a sulfate is the stable matter, usual is rich -- gaseous mixture -- even if it carries out combustion operation, it will be hard to be emitted from an occlusion reduction type NOX catalyst, and the amount of SOX occlusion will increase gradually. Since the occlusion possible amount of the nitrate in an occlusion reduction type NOX catalyst or a sulfate is limited, If the amount of occlusion of the sulfate in an occlusion reduction type NOX catalyst increases (SOX poisoning is called hereafter), since only the part will decrease, the amount in which the occlusion of a nitrate is possible if the amount of occlusion of the sulfate in an occlusion reduction type NOX catalyst is not decreased (SOX poisoning recovery or sulfur desorption playback is called hereafter) -- at last -- \*\* -- it will become impossible to completely absorb NOX

[0005] It can decompose into SO<sub>2</sub> and a sulfate can be made to emit from a catalyst as a gas, when an occlusion reduction type NOX catalyst becomes 600-degree elevated temperature which is about C and a surrounding oxygen density falls. It is required to burn HC and CO for example, on an occlusion reduction type NOX catalyst, and to carry out the temperature up of the occlusion reduction type NOX catalyst by that cause, for sulfur desorption playback (SOX poisoning recovery). In order to carry this out, operating with a rich air-fuel ratio periodically is performed.

[0006] Sulfur desorption playback (SOX poisoning recovery) is aimed at returning and emitting K<sub>2</sub>SO<sub>4</sub> to SO<sub>2</sub>. However, since operation is performed with the strong rich air-fuel ratio, reduction



components, such as H<sub>2</sub>, exist and SO<sub>2</sub> from which it was once desorbed may be returned further S or H<sub>2</sub>S. And occlusion of these S or H<sub>2</sub>S will be again carried out to a catalyst in the form of K<sub>2</sub>SO<sub>4</sub>, and a catalyst will poison. In this way, the following desorption was controlled and making a sulfur content emit from a catalyst completely as SO<sub>2</sub> has taken long duration. Therefore, to the usual transit, even if the rate of NO<sub>x</sub> purification was able to fall, without the ability carrying out SO<sub>x</sub> poisoning recovery easily and it was able to carry out SO<sub>x</sub> poisoning recovery, aggravation of fuel consumption is caused.

[0007] in order to shorten the processing time of sulfur desorption playback (SO<sub>x</sub> poisoning recovery) -- an average air-fuel ratio -- weakness -- by making it rich and repeating Lean/Rich, controlling reduction to S or H<sub>2</sub>S is proposed. However, playback time amount is slightly shortened by seeing microscopically too and repeating poisoning and the poisoning recovery by reoxidation. Moreover, in order to control re-poisoning, when it is going to perform sulfur desorption under the air-fuel ratio near SUTOIKI, reducing power is weak and sulfur desorption hardly happens.

[0008] It is effective to, oxidize beforehand NO by which occlusion cannot be carried out easily to NO<sub>2</sub> on the other hand, in order to raise the rate of NO<sub>x</sub> purification by the occlusion reduction type NO<sub>x</sub> catalyst. Then, JP,11-324652,A arranges a plasma generator for the upstream of an occlusion reduction type NO<sub>x</sub> catalyst, and is indicating the exhaust emission control device which was made to change NO into NO<sub>2</sub> and aimed at improvement in occlusion capacity. However, in this exhaust emission control device, if a plasma generator is always operated and the plasma is generated, the problem that an energy loss is large will arise.

[0009]

[Problem(s) to be Solved by the Invention] This invention is made in view of the trouble mentioned above, and it is shown in aiming at improvement in the rate of purification in the exhaust emission control device which has arranged the occlusion reduction type NO<sub>x</sub> catalyst and the plasma generator to an internal combustion engine's flueway by quickening the emission and reduction of harmful matter, such as NO<sub>x</sub> and SO<sub>x</sub>, by which occlusion was carried out to the catalyst, the purpose operating a plasma generator efficiently and controlling energy expenditure.

[0010]

[Means for Solving the Problem] In order to attain the above-mentioned purpose, according to the first side face of this invention Or it sets to this occlusion reduction type NO<sub>x</sub> catalyst and the exhaust emission control device of the internal combustion engine with which the plasma generator has been arranged in one. while an occlusion reduction type NO<sub>x</sub> catalyst is arranged in a flueway -- this occlusion reduction type NO<sub>x</sub> catalyst -- the flueway of the upstream -- When processing to which the harmful matter by which occlusion was carried out to said occlusion reduction type NO<sub>x</sub> catalyst is made to emit is performed, an internal combustion engine's exhaust emission control device characterized by establishing the control means which operates said plasma generator is offered.

[0011] Since a plasma generator operates and the plasma occurs at the time of rich operation for the time of rich spike operation for the time of activation of the processing to which the harmful matter by which occlusion was carried out to the occlusion reduction type NO<sub>x</sub> catalyst is made to emit, i.e., reduction and purification of NO<sub>x</sub>, or poisoning recovery of SO<sub>x</sub>, while emission of harmful matter and a reduction reaction progress promptly, in order that a plasma generator may not operate in all fields, energy expenditure is controlled in this exhaust emission control device.

[0012] Moreover, according to the second side face of this invention, when it is below the first [predetermined / control means / said / in the temperature of said occlusion reduction type NO<sub>x</sub> catalyst] desirable temperature, or also when it is beyond the second predetermined temperature higher than this first temperature, said plasma generator is operated further. When whenever [catalyst temperature] is high, or when low, the absorption coefficient of NO<sub>x</sub> becomes low, but in this exhaust emission control device, since a plasma generator operates and the plasma occurs also when such, improvement in the rate of NO<sub>x</sub> purification is achieved.

[0013] Moreover, according to the third side face of this invention, preferably, an oxidation catalyst is arranged at the preceding paragraph of said occlusion reduction type NO<sub>x</sub> catalyst, and said plasma generator is arranged between said oxidation catalyst and said occlusion reduction type NO<sub>x</sub> catalyst. In this exhaust emission control device, an excessive reducing agent will be consumed

according to an oxidation catalyst by an oxidation catalyst being arranged at the preceding paragraph of a plasma generator, the amount to which active species generated in the operation of the plasma, such as NO<sub>2</sub> and active oxygen, react with a reducing agent will be made to decrease, and sufficient active species will be sent to an occlusion reduction type NOX catalyst.

[0014] Moreover, according to the fourth side face of this invention, said occlusion reduction type NOX catalyst is supported in the particle matter by the filter in which uptake is possible.

[0015]

[Embodiment of the Invention] Hereafter, the operation gestalt of this invention is explained with reference to an accompanying drawing.

[0016] Drawing 1 is the schematic diagram showing the whole exhaust-emission-control-device configuration of the internal combustion engine concerning 1 operation gestalt of this invention. A sign 10 shows the body of a Diesel engine or a lean combustion gasoline engine. The generator 12 driven with the engine body 10 is connected to the engine body 10. The electrical and electric equipment you were made to generate with a generator 12 is stored in a dc-battery 14.

[0017] Two catalysts are arranged in the flueway 20 which extends from the engine body 10. The catalyst of the downstream is the occlusion reduction type NOX catalyst 22, and the catalyst of the upstream is an oxidation catalyst 24. And the plasma generator 26 is arranged between the oxidation catalyst 24 and the occlusion reduction type NOX catalyst 22. In addition, the plasma generator 26 may be carried in the occlusion reduction type NOX catalyst 22 in one.

[0018] Power is supplied to the plasma generator 26 from power supply 28. Power supply 28 adjusts the frequency and an alternating-voltage value, and changes the injection power to the plasma generator 26 while it changes into alternating voltage the direct current voltage supplied from a dc-battery 14.

[0019] An electronic control (ECU) 30 controls the engine body 10 and power supply 28, and operates in response to supply of power from a dc-battery 14. An electronic control 30 receives the output signal of the air-fuel ratio (A/F) sensor 32 formed in the upstream from the oxidation catalyst 24, and the various sensors of the exhaust gas temperature sensor 34 grade prepared between the plasma generator 26 and the occlusion reduction type NOX catalyst 22 while detecting the operational status of the engine body 10. Moreover, an electronic control 30 can detect mileage from the mileage counter 36 formed in the car with which the engine was carried.

[0020] Drawing 2 is a flow chart which shows the procedure of the exhaust air purification processing performed by ECU30. First, at step 102, while an air-fuel ratio, an exhaust-gas temperature, and mileage are detected, respectively from each output of the A/F sensor 32, an exhaust gas temperature sensor 34, and the mileage counter 36, whenever [ catalyst temperature / of the occlusion reduction type NOX catalyst 22 ] is presumed from engine operational status.

[0021] Subsequently, at step 104, it is judged for the mileage from the time of activation of the last SOX poisoning recovery whether it is beyond a predetermined value. When the mileage is beyond a predetermined value, while it progresses to step 106 and SOX poisoning recovery is performed, when mileage is under a predetermined value, it progresses to step 108. In addition, you may make it judge the activation stage of recovery by the fall of the amount of NOX occlusion of the NOX catalyst 22.

[0022] SOX poisoning recovery is performed at step 106, adjusting the frequency and electrical-potential-difference value of supply alternating voltage according to an exhaust-gas temperature and an air-fuel ratio, and operating the plasma generator 26. It is controlled by this SOX poisoning recovery so that the core of an air-fuel ratio serves as SUTOIKI or weak Rich. Therefore, the amount of reduction components in exhaust gas, such as H<sub>2</sub> and CO, becomes few things as compared with the conventional SOX poisoning recovery currently performed under the strong rich air-fuel ratio. However, a reduction component is activated by actuation of the plasma generator 26, and since the reducing power is strong, you can make it desorbed from a catalyst to sulfur for a short time also of the reduction component of few constant rates.

[0023] And since deer generation of the reduction components, such as H<sub>2</sub>, is not carried out only, the principal component by decomposition of a sulfate serves as SO<sub>2</sub>, and re-poisoning of a catalyst is controlled. That is, if hydrogen exists in a surplus, S and H<sub>2</sub>S will be generated by the reaction  $SO_4^{2-} + (HC^* \text{ or } H_2 \text{ or } CO) \rightarrow SO_2 + CO_2$  and  $H_2O + SO_2 + 2H_2 \rightarrow S + 2H_2O$  and  $SO_2 + 3H_2 \rightarrow H_2S + 2H_2O$ , and



re-poisoning will happen. However, with this operation gestalt, since SOX poisoning recovery is performed by activating with the plasma the little reducing gas produced by operation with the air-fuel ratio near SUTOIKI, a sulfate is decomposed, the further reduction to S or H<sub>2</sub>S is not produced only by emitting as SO<sub>2</sub>, and re-poisoning does not happen. This routine is ended after activation of step 106.

[0024] It is judged [ of rich spike operation ] at step 108 performed when the execution condition of SOX poisoning recovery is not satisfied at step 104 whether it is under activation. Namely, in this operation gestalt, although rich spike operation for reduction and purification of NOX is periodically made in the fuel-injection control currently performed separately, it is judged [ this ] whether it is [ rich spike ] under operation.

[0025] It progresses to step 110, and the plasma generator 26 is made to operate, if it is [ rich spike ] under operation, adjusting the frequency and electrical-potential-difference value of supply alternating voltage according to an exhaust-gas temperature and an air-fuel ratio. In this way, the reduction component in exhaust gas (HC) is activated, and the reduction of NOX by which occlusion was carried out to the occlusion reduction type NOX catalyst 22 is promoted. This routine is ended after activation of step 110.

[0026] When judged with there being nothing during rich spike operation at step 108, it progresses to step 112 and it is judged whenever [ catalyst temperature / of the occlusion reduction type NOX catalyst 22 ] whether TC is less than [ predetermined / temperature T1 ]. If it is in the catalyst low-temperature field to which  $TC < T1$  is materialized, it progresses to step 110 and the plasma generator 26 is made to operate. The oxidation reaction which becomes  $NO + (1/2) O_2 \rightarrow NO_2$  is promoted in this way, and NO is changed into NO<sub>2</sub> which occlusion is easy to be carried out to the NOX catalyst 22.

[0027] When judged with there being nothing to a low-temperature field at step 112, it progresses to step 114 and it is judged whether TC is [ whenever / catalyst temperature / of the occlusion reduction type NOX catalyst 22 ] larger than the predetermined temperature T2 ( $T1 < T2$ ). If it is in the catalyst elevated-temperature field to which  $T2 < TC$  is materialized, it progresses to step 110 and the plasma generator 26 is made to operate. Although the occlusion of NOX becomes is hard to be carried out in a catalyst elevated-temperature field, when the active oxygen generated with the plasma reacts with NOX, the oxidation to NO<sub>2</sub> of NOX is promoted, the occlusion to a catalyst progresses, and the rate of NOX purification improves.

[0028] When conditions are not satisfied at all steps 104, 108, 112, and 114, it progresses to step 116 and actuation of the plasma generator 26 is suspended. In this way, in order that a plasma generator may not operate in all fields, a result by which energy expenditure is controlled is brought.

[0029] In addition, it is desirable to face to adjust the electrical-potential-difference value and frequency of alternating voltage which are supplied to the plasma generator 26 according to an exhaust-gas temperature and an air-fuel ratio in order to operate the plasma generator 26, and to switch a control map the warming-up front of the occlusion reduction type NOX catalyst 22 and after warming up. Drawing 3 and drawing 4 are drawings which illustrate the map which defined the electrical-potential-difference value and frequency of supply alternating voltage to a plasma generator according to the exhaust-gas temperature and the air-fuel ratio (A/F), drawing 3 is applied before catalyst warming up, and drawing 4 is applied after catalyst warming up, respectively. Although the frequency is enlarged before catalyst warming up as compared with the catalyst warming-up back, this is made to respond to the catalyst not being activated before catalyst warming up according to these maps.

[0030] Moreover, in this operation gestalt, it has the composition that an oxidation catalyst 24 is arranged at the preceding paragraph of the occlusion reduction type NOX catalyst 22, and the plasma generator 26 is arranged between an oxidation catalyst 24 and the occlusion reduction type NOX catalyst 22. Therefore, an excessive reducing agent will be consumed by the oxidation catalyst 24, the amount to which active species generated in the operation of the plasma, such as NO<sub>2</sub> and active oxygen, react with a reducing agent will be made to decrease, and sufficient active species will be sent to the occlusion reduction type NOX catalyst 22.

[0031] In addition, an occlusion reduction type NOX catalyst may adopt the configuration supported in the particle matter by the filter in which uptake is possible. That is, in a Diesel engine, although a

particulate (particle) discharge increases, since a particulate cannot fully be reduced, the filter which carries out the trap (uptake) of the particulate to an exhaust air system as after treatment may be prepared only by improvement of combustion. In this case, it is possible to make the particulate filter support an occlusion reduction type NOX catalyst.

[0032]

[Effect of the Invention] Improvement in the rate of purification of exhaust gas is achieved by quickening the emission and reduction of harmful matter, such as NOX and SOX, by which occlusion was carried out to the catalyst, operating a plasma generator efficiently and controlling energy expenditure according to this invention, as explained above.

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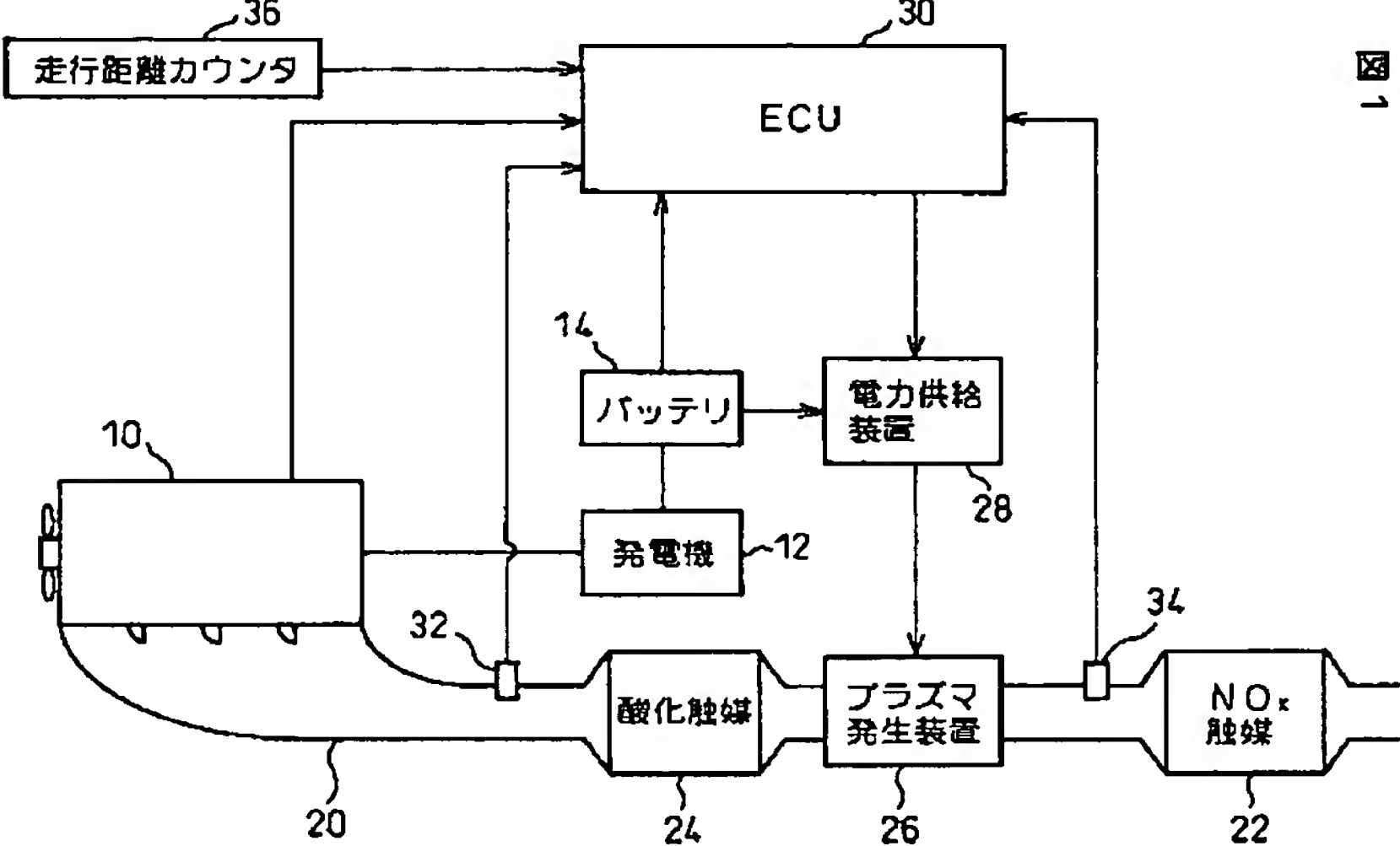
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DRAWINGS

[Drawing 1]



[Drawing 3]

図 3 電圧と周波数のマップ（触媒暖機前）

リーン ↑ A/F ↓ リッチ	20000V 14 kHz	14000V 14 kHz	14000V 14 kHz	作動停止
	20000V 12 kHz	14000V 12 kHz	14000V 12 kHz	作動停止
	20000V 10 kHz	14000V 10 kHz	14000V 10 kHz	作動停止
	20000V 8 kHz	14000V 8 kHz	14000V 8 kHz	作動停止
	100	200	300	400
	排気温度 [℃]			

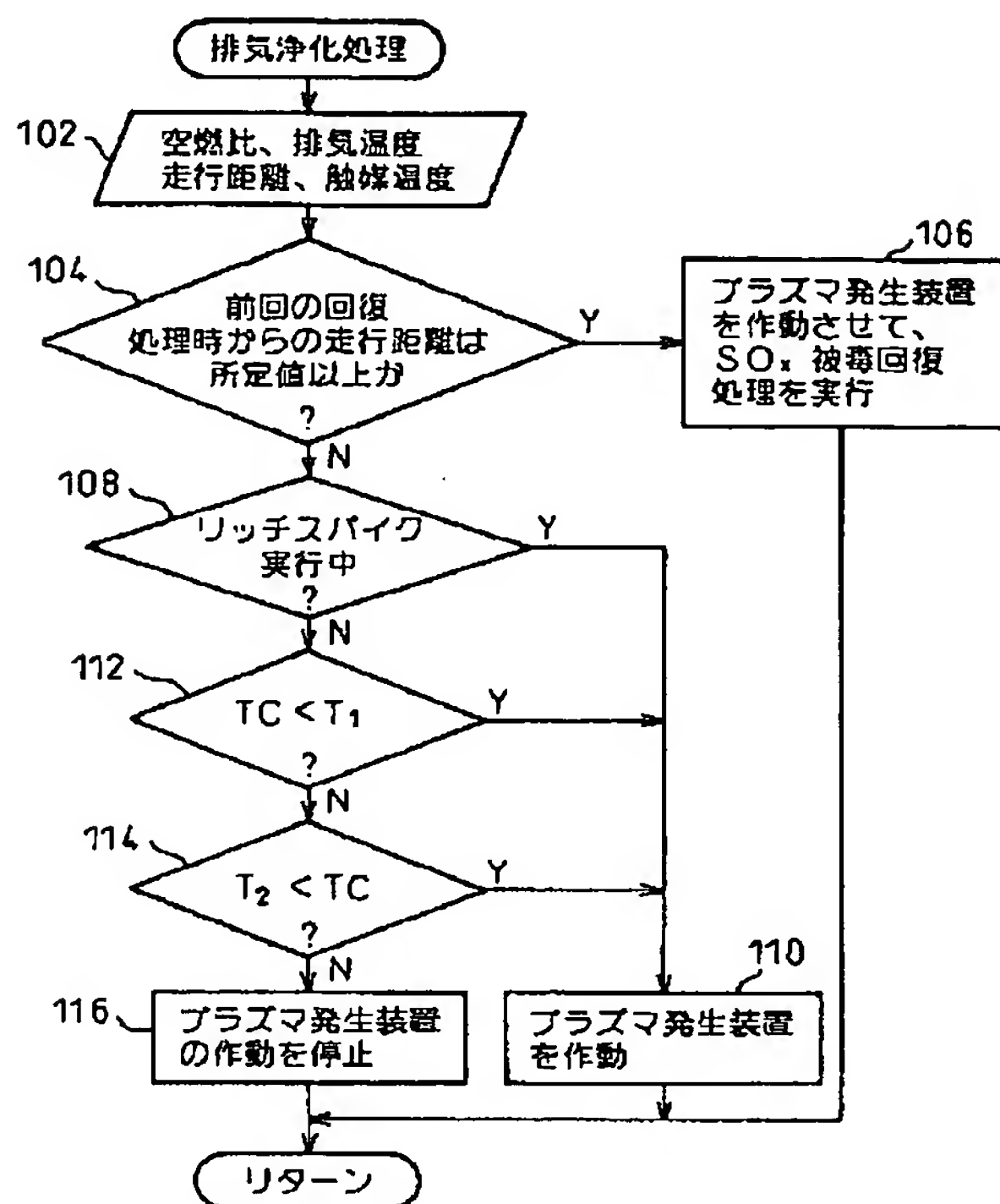
[Drawing 4]

図 4 電圧と周波数のマップ（触媒暖機後）

リーン ↑ A/F ↓ リッチ	20000V 10 kHz	14000V 10 kHz	14000V 10 kHz	作動停止
	20000V 8 kHz	14000V 8 kHz	14000V 8 kHz	作動停止
	20000V 7 kHz	14000V 7 kHz	14000V 7 kHz	作動停止
	20000V 6 kHz	14000V 6 kHz	14000V 6 kHz	作動停止
	100	200	300	400
	排気温度 [℃]			

[Drawing 2]

図 2



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